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ABSTRACT

Bloom has argued that most students, not just a few, should be able to do top quality school work if given appropriate instruction. Mastery learning, which includes frequent diagnostic testing followed by remedial instruction, has been proposed as an effective strategy for increasing pupil achievement. In this study, teachers used a mastery learning strategy with elementary school students in a geometry unit. An analysis of the data indicated that low mathematics aptitude fourth graders taught using a mastery strategy achieved at as high a level as high aptitude fifth graders taught in a more conventional manner. (Author)

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The Effects of a Mastery Learning Strategy on Achievement

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Bloom (1968) has hypothesized that instruction can be organized to enable most students to achieve at a level accomplished now by only the best students. To reach this high level of achievement requires instruction that includes clear statements of outcomes, diagnostic testing, and additional opportunities to learn for students who fail to accomplish objectives. Bloom uses the term "mastery learning" to describe this strategy designed to aid nearly all students in learning regardless of their aptitude.

The effect of using mastery learning has been examined in a number of research studies (Block 1971, 1973). Although the high level of student success that Bloom hypothesized has not always materialized, substantial increases in student achievement have resulted from following the diagnostic-prescriptive process that is at the heart of mastery learning.

Because performance objectives and related diagnostic tests are essential parts of mastery learning they have received special attention in mastery research. An example of this is an investigation by Collins (1971) who studied mathematics learning with six groups of learners.

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Among the treatments were groups which received objectives or test items to supplement regular instruction. Collins reported an increment in performance of about 20 percent when objectives were provided and about a 10 percent increase by providing students with test items following instruction. However, when results from diagnostic tests were used to guide remedial instruction, learner performance increased about 40 percent above that of a control group. The net result was to approximately double achievement of students receiving mastery teaching compared to students receiving instruction with no embellishment.

The intent in this study was to replicate some parts of the Collins investigation and, in addition, to examine the effects of mastery learning on students of different aptitudes and grade levels. The prospect of reducing the effects of these individual differences is an important part of the mastery hypothesis.

The first purpose of the study, therefore, was to examine the individual and cumulative effects on achievement of providing students with objectives, sample test items, and a mastery strategy that included diagnostic testing and remedial instruction. A second purpose was to examine the effects of mastery learning on achievement of students with different aptitudes for learning and from different age groups or grade levels. Carroll (1963) and Bloom (1968) contend that quality instruction and time to learn a task should negate the usual positive correlations of these individual difference variables with achievement.

PROCEDURE

Eighty-four students from two fourth-grade and two fifth-grade classes (all in the same school) were selected for the study. The regular

teachers from the four classrooms and an instructional aide carried out the treatments and collected all classroom data.

The students were stratified by grade level and blocked on two levels of mathematics aptitude (above and below the 50th percentile) measured with the Arithmetic Skills Test of the Iowa Test of Basic Skills. Students were then assigned at random to one of four treatment groups. Because fewer than half the students had arithmetic skills scores above the 50th percentile, the 2 x 2 x 4 design (grade level x mathematics aptitude x treatment) yielded 16 cells with unequal n's.

Commercially published materials for teaching elementary geometry skills were used throughout the study.* The geometry materials covered the topics of perimeter, radius, circumference, diameter, angles and triangles, symmetry, and use of a ruler, compass, and protractor. Students studied the materials on an individual basis by completing exercises in a series of skill booklets. A total of 14 skills were to be learned that ranged from knowledge level (e.g., defining the radius of a circle) to application items (e.g., constructing an angle congruent to a given angle).

Before beginning the experimental phase of the study, all students completed a series of mathematics exercises to attempt to bring them to the same level of background knowledge on the skills to be learned. This involved studying the prerequisite geometry materials from the same publisher intended for first, second, and third graders. In addition to providing an even start for students, the two weeks of prerequisite instruction allowed both teachers and students to become familiar with materials like those used in the study.

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*Permission to use materials from the program Math Modules was granted by the publisher, Appleton Century Crofts.

Following the prerequisite instruction, students studied 45 minutes daily for 14 days under one of four treatment conditions.**

Group 1: This control group received only instruction from the 14 skill booklets on an individual basis. Teachers clarified terms, answered procedural questions, and recorded student progress as students completed study of one skill after another.

Group 2: This group received the same basic instruction as Group 1 supplemented by stated performance objectives for each of the 14 skills in the geometry unit. Before students began any booklet the teachers would read the appropriate objective, clarify any terms associated with it, review related skills, and encourage reference to the objective as they worked.

Group 3: This group received the same basic instruction as Group 1 supplemented with sample test items for each of the 14 skills in the geometry unit. With this group teachers told students to study the sample test items, clarified terms used in the items reviewed related skills, and suggested that students refer to the sample test items as they studied.

Group 4: This group received the basic instruction provided Group 1 plus performance objectives and sample test items presented in the same way as to students in Groups 2 and 3. In addition, students completed diagnostic tests when they finished the study of any skill booklet. This test was corrected quickly and students that needed to were directed to additional instruction until they demonstrated mastery of the skill.

Before beginning the experiment, the participating teachers were informed of all details of the study. They examined the teaching materials to be sure they were familiar with the geometry concepts to be studied and learned how each treatment was to be conducted. During the study, the teachers rotated each day to a different group and followed written instructions on the appropriate means of administering that treatment to insure that teacher influence was not confounded with experimental effects.

**Specific directions given to the teachers for each of the four treatments and the instruments used to measure achievement can be obtained from the first author.

Students worked individually and at their own pace. If they finished their work before the end of the period on any day they were directed to studies in another curriculum area. For Groups 1, 2, and 3, the teachers worked alone with the students. In Group 4 (the mastery strategy), the teacher was assisted by the instructional aide who kept all records of pupil progress. The aide was cautioned, however, not to instruct students in their geometry lessons.

Student achievement was measured with a 42-item test supplied by the publisher of the mathematics materials. The questions on the test related directly to the 14 objectives of the geometry skills unit so no additional means of establishing test validity were used. Reliability of the criterion measure was found to be 0.75 by the test-retest method with a sample of fourth and fifth graders from another school. The criterion test was administered to all students on the day following completion of the study and then given again two weeks later.

RESULTS

Mean scores and standard deviations for all subgroups of students on the posttest are given in Table 1. Analysis of these data (see Table 2) revealed a highly significant treatment effect and an expected significant difference in achievement between students in the high and low mathematics aptitude groups. No significant differences in achievement were found between fourth and fifth grade students. Further analysis of the scores using the Newman-Keuls procedure (Kirk, 1968) indicated that Group 4 (the mastery strategy) scored significantly higher than all other treatment groups. There were no significant differences in achievement among the first three groups.

Insert Table 1 about here

Insert Table 2 about here

Although retention test data are not presented here, the same pattern of findings as on the posttest held for the retention test given two weeks later. Comparison of the scores on the posttest and retention test also showed no significant drops in achievement for any of the groups.

Bloom (1968) has predicted that the correlation between aptitude and achievement should approach zero as the effectiveness of an instructional program increases. To test this prediction the mathematics aptitude scores and the posttest achievement scores were correlated for each of the four treatment groups and are shown in Table 3. Of these, only the correlation coefficient for Group 4 (the mastery strategy) is not significantly different from zero.

Insert Table 3 about here

A further analysis of the effect that the mastery strategy had on achievement among low aptitude students is shown in Figure 1. Mean scores on the posttest for only the control group (Group 1) and the mastery group (Group 4) are shown. As indicated on the graph, students of low mathematics aptitude receiving the mastery treatment performed better (on the average) than high mathematics aptitude students in the control group. Mean scores from Table 1 also show that fourth graders of low mathematics aptitude who received the mastery treatment scored as well on the posttest as fifth graders of high mathematics aptitude in the control group.

Place Figure 1 about here

DISCUSSION

Providing students with a combination of objectives, test items, diagnostic tests and remediation in conjunction with an individualized mathematics program significantly altered achievement. The effectiveness of the comprehensive mastery strategy was significantly greater than the use of the individual components of objectives, test items, or individualized materials. It was with low aptitude students that the mastery strategy was especially beneficial.

The findings in this study strongly support Bloom's hypothesis that many students can achieve at high levels if instruction is organized appropriately. By providing students with mastery instruction it was possible to minimize the advantage expected for older, higher-aptitude students. Of course, the oldest students of high aptitude did perform best, but comparisons of achievement among students in the mastery and control groups show how the achievement gap was narrowed by mastery instruction that attended individually to the performance of students.

The results of this study support Collins' finding that a mastery strategy will have a pronounced effect on pupil achievement when compared to instruction with no (or limited) built-in provisions for diagnosis and remediation. However, Collins' findings of significant increases in achievement for students provided with objectives is not supported. Slight but not significant increases in achievement resulted in this study when objectives or test items were provided to students.

Classroom instruction is frequently characterized by fixed time schedules and varying achievement. Even if students fail to achieve in a unit the class moves on. Bloom, however, has regarded "time to learn" as an important variable to be manipulated during instruction. Students receiving the mastery treatment in this study were given objectives-referenced, diagnostic tests following their study. Learning problems of individual students were identified with these tests and additional instruction (and time) prescriped for students to help them achieve.

The time alloted to the four treatment groups in this study was the same (45 minutes daily for 14 days) but within the allotment, the mastery group used more time than any of the others. In addition to the regular individualized study that everyone received, the mastery group took additional time to complete diagnostic tests and remedial instruction. Consequently, the experiment is somewhat confounded by the fact that the time for treatments was not strictly controlled. Additional studies are needed to determine if the effects of mastery learning are maintained under more tightly controlled time conditions.

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TABLE 1

Cell Means and Standard Deviations on the Criterion Measure
(Posttest)

Math Aptitude		Instructional treatment											
		Group 1			Group 2			Group 3			Group 4		
		n	Mean	S.D.	n	Mean	S.D.	n	Mean	S.D.	n	Mean	S.D.
5th Grade	High	3	30.66	2.51	2	31.50	2.12	2	32.00	2.83	3	35.33	5.03
	Low	5	17.40	7.12	6	23.83	5.07	7	26.57	3.25	6	31.00	4.51
4th Grade	High	6	28.33	6.44	6	29.83	7.44	3	28.00	5.19	4	34.75	2.62
	Low	7	18.14	3.34	7	21.71	5.47	9	18.77	7.58	8	30.25	3.37
Total		21	22.67	5.48	21	25.57	5.60	21	23.95	5.58	21	32.05	3.79

TABLE 2

Analysis of Variance on Posttest Scores for Main and Interaction Effects

Sources	Degrees of Freedom	Sums of Squares	Mean Squares	F Ratios
Grade, (G)	1	90.54	90.54	3.21
Aptitude, Math Skills Scores (A)	1	1040.55	1040.55	36.89**
Treatment, (T)	3	832.98	277.66	9.85*
GA	1	.47	.47	.02
GT	3	70.67	23.56	.84
AT	3	126.25	42.08	1.49
GAT	3	24.65	8.22	.29
Error	68	1917.84	28.20	
Total	83	4103.94		

*$p < 0.005$
**$p < 0.001$

TABLE 3

Correlations between Posttest Scores and Math Aptitude

Group	1	2	3	4	Total
n	21	21	21	21	84
Correlation Coefficient	0.84*	0.76*	0.72*	0.12	0.46*

*$p < 0.01$

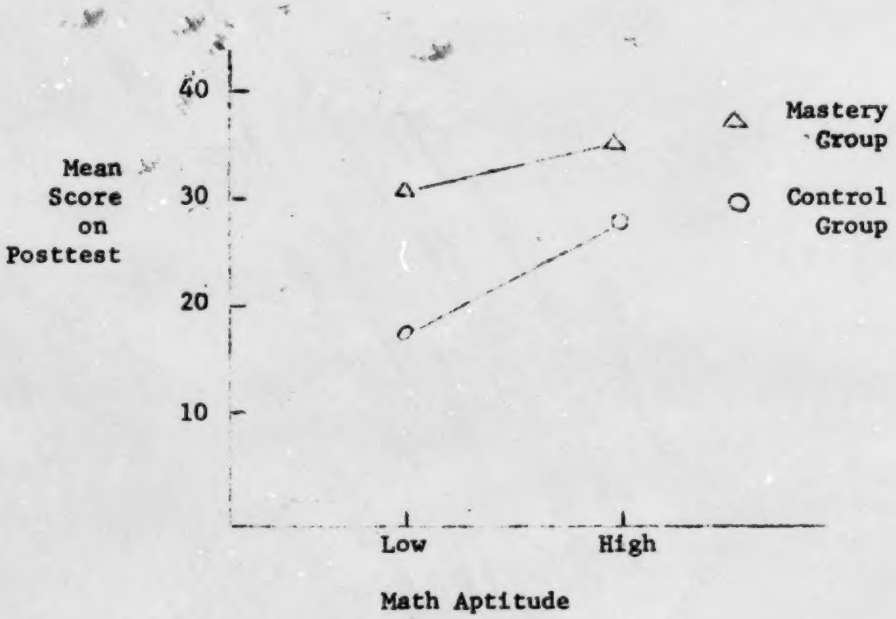

Figure 1. Posttest scores of mastery and control group students with high and low math aptitude.